REVISED

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1603 rev. Aug. 1937

PLANTING and care of SHELTERBELTS on the NORTHERN GREAT PLAINS

A SHELTERBELT demonstration project was started in 1916 by the Northern Great Plains Field Station at Mandan, N. Dak., in cooperation with farmers in the Plains section of Montana, North Dakota, South Dakota, and Wyoming. The main objects were to stimulate interest in the improvement of farm homes by the planting of belts of trees near the farm buildings, orchards, and gardens, and to determine by actual trial the kinds of trees best suited to the different sections and the best methods of handling them.

A limited number of farmers each year have been supplied with trees to be planted and cared for in accordance with plans and instructions furnished by the Department of Agriculture. At the end of 1935 more than 4,000 shelterbelts, varying in age from 1 to 20 years, had been established. The methods described in this bulletin are based on studies of this number of farm plantings from the period of seed collection through the growing of the nursery stock, the laying out and preparing of the planting sites, and the preparation of planting plans, to the present time.

The important items to be considered by the tree planter are: (1) Location and selection of the shelterbelt site; (2) the preparation of the soil before planting; (3) the choice of species and kinds of trees; (4) the source of planting stock; (5) the preparation of a planting plan showing the arrangement of species and spacing distances; (6) planting methods; and (7) the cultivation and general protection of the trees after planting.

Washington, D. C.

Issued August 1929
Revised August 1937

PLANTING AND CARE OF SHELTERBELTS ON THE NORTHERN GREAT PLAINS

By ROBERT WILSON, *associate arboriculturist, Division of Dry Land Agriculture, Bureau of Plant Industry*

Revised by ERNEST J. GEORGE, *associate silviculturist*

CONTENTS

LOCATION AND SIZE OF SHELTERBELTS

SHELTER FOR BUILDINGS AND YARDS

WINTER PROTECTION is the important consideration in locating a shelterbelt for buildings and yards. Over much of the northern Great Plains winter storms come from a northwesterly direction, but in small areas in the western part of the region there are severe winter storms from the southwest. The shelterbelt should therefore be located on either the north and west or on the south and west of the buildings, depending on the direction of the prevailing winter storms, so as to form a belt of uniform width in the shape of an L. If the buildings are so located that it is not possible to plant trees on two sides, the shelterbelt may be laid out as a single strip on the side of the prevailing wind.

No hard and fast rule can be laid down as to the distance that should be allowed between the buildings and the inside edge of the shelterbelt. Conditions vary on each farm, and the distance is governed largely by the site and the number of rows to be planted to trees. For maximum protection to buildings against wind it is necessary to have the inside row of trees within about 20 feet of them. For maximum protection to the same buildings against drifting snow it may be necessary to place the inside row from 50 to 75 feet away, owing to the possibility of snow passing through and drifting

on the leeward side of the trees. An ideal shelterbelt for maximum wind and snow protection is one that comes within about 20 feet of the buildings and is composed of a sufficient number of rows of trees to prevent any possibility of snow passing through and drifting on the leeward side against the buildings.

The possibility of drifting snow accumulating against farm buildings or in farmyards should be guarded against, even at the expense of lessened wind protection. When belts of only one to seven rows

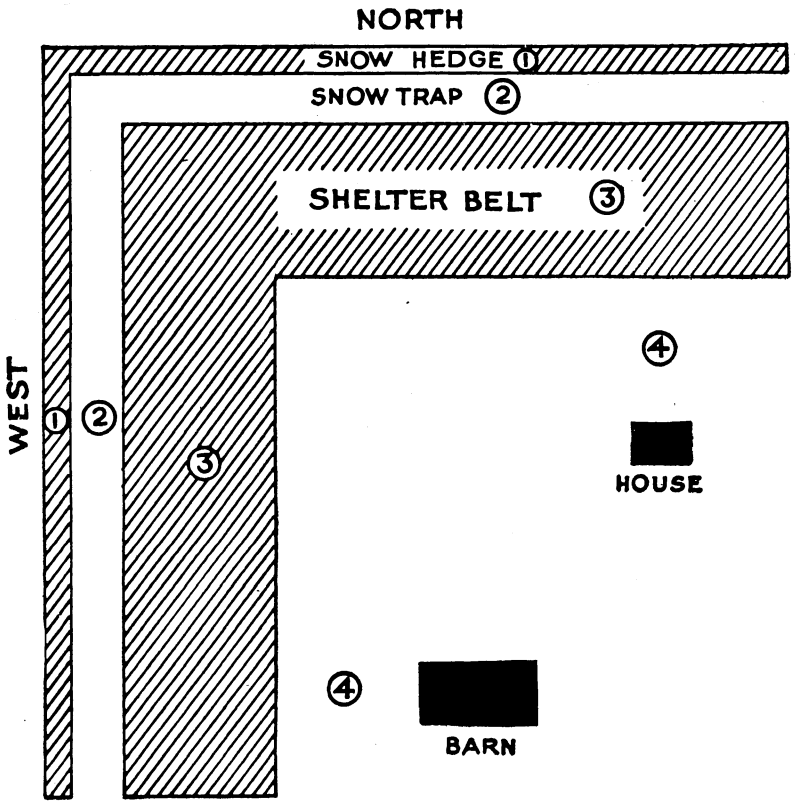

FIGURE 1.—Plan of a shelterbelt recommended for buildings and yards. 1, Snow hedge, minimum of 30 feet wide. 2, Snow trap, 30 to 60 feet wide. 3, Shelterbelt, 75 to 150 feet wide. If the snow trap and snow hedge are not included, this block should contain at least 8 rows of trees. 4, Space 20 to 75 feet wide between inside row of shelterbelt and buildings.

are planted on exposed sites, the inside row of trees should be farther from the buildings than it would be if the site were protected or the belt were wider.

For effective protection against winter winds and drifting snow, belts should consist of not less than eight rows of trees. This number may well be increased to 10 or 15 rows if sufficient land is available and a snow trap is included, as shown in figure 1. Areas of land less than 100 feet wide should be planted to solid belts. The length of the belt should be such that protection will be afforded to all build-

ings and to the area for which protection is desired. How the buildings are protected from drifting snow is shown in figure 2.

SHELTER FOR ORCHARDS AND GARDENS

Protection from strong drying winds and intense heat is of first importance in planning the location of a shelterbelt for orchards and gardens. Ordinarily, protection is most needed on the north, south, and west, although shelter on the east may prove of value. A shelterbelt for orchard and garden protection need not be so wide as that required for winter protection of buildings and yards. One to four rows of trees will usually provide sufficient protection against wind and heat. Drifting snow carried through the belt will oftentimes benefit orchard and garden crops.

The shelterbelt should be placed at least 50 feet away from the area to be planted to orchard or garden crops. Shelterbelt trees send out

FIGURE 2.—Before it reaches the farm buildings the snow is collected within a shelterbelt.

their roots in cultivated land for some distance, and in dry years they will rob of moisture crops planted within 50 feet.

In figure 3 is shown the relative location of shelterbelt and orchard or garden.

SELECTION OF PLANTING SITE

The rainfall in the region is below that considered necessary for successful tree growth and survival. Therefore the importance of selecting a planting site on which the soil will absorb the maximum amount of rainfall and permit ready penetration of tree roots cannot be overemphasized, if the shelterbelt is to attain the highest degree of survival and growth for giving adequate protection to the farmstead. Unfortunately, the farmer in many cases cannot choose the most favorable site as to soil type when planning shelterbelts for the protection of buildings, and only very infrequently is he able to modify moisture conditions. Usually the buildings are constructed before thought is given to tree planting, and consequently the area of land suitable for trees for protection purposes is fairly sharply defined. Planters of farm shelterbelts should, therefore, be prepared

to meet with perhaps failure or only minor success, if the trees of necessity have to be planted on unfavorable sites.

The following discussion of soils may be of assistance to those farmers who are able to exercise some choice in the selection of the planting site but who are unable to modify the soil-moisture conditions. Farm shelterbelts are generally planted on upland prairie soils that vary widely as to texture, ranging from clays of fine texture, sometimes characterized as "tight", through the clay, silt, and sandy loams of medium texture to the fine sands, coarse sands, and gravels. Some soils are underlain by a hardpan layer in the form of calcareous deposits. These layers are found at depths from 6 inches below the soil surface to below the depth penetrated by tree

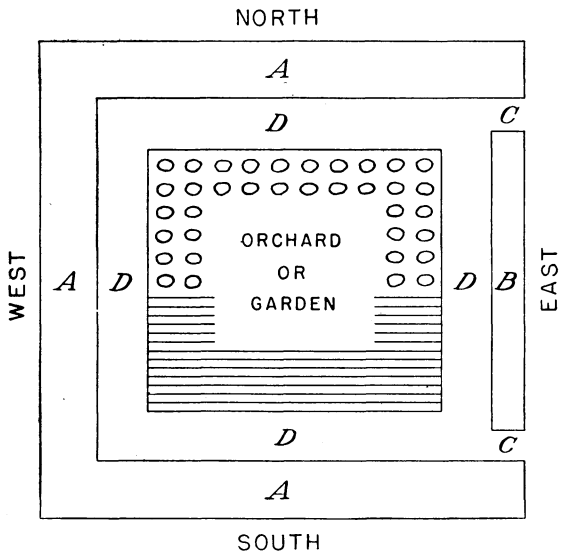

FIGURE 3.—Recommended plan of a complete shelterbelt for an orchard or garden: *A*, Shelter on the north, west, and south, of first importance, two to four rows of trees; *B*, shelter on the east, of second importance, one or two rows of trees; *C*, turning space and driveways; D, a space of at least 50 feet between the shelterbelt and the orchard or garden.

roots. Frequently this layer is found within the first 2 feet and tree roots are unable to penetrate it, either as a result of absence of moisture or from toxic effects.

As a rule, trees make only a very stunted growth on such soils, unless moisture conditions are very favorable, and oftentimes they suffer very heavy killing back or complete elimination.

Small basinlike depressions, locally called "alkali spots", which appear distinctly unfavorable for tree growth, are occasionally encountered.

Observations made over a period of years of tree roots growing in soils that possess the hardpan layer show that roots do not penetrate it. Laterals turn sharply at right angles and run horizontally immediately above the layer (fig. 4). Entire root systems of 15-year-old ash trees on such soils have been taken from holes approximately 1 foot in depth and 2 feet in diameter. Shelterbelts

can never be grown successfully on soils of this class, unless conditions are made favorable by the practice of irrigation or by planting the trees on contour ditches.

For purposes of tree planting, the soils of the region may be divided on the basis of site into three general classes, favorable, semifavorable, and unfavorable. Each class is limited according to fineness or coarseness of the soil texture and by certain other characteristics which make it favorable or otherwise for tree growth.

Favorable sites include soils of a coarse texture, such as sands and sandy loams. Such soils absorb the maximum amount of precipitation and suffer a minimum of run-off. They permit deep penetration of moisture, thereby reducing evaporation from the soil,

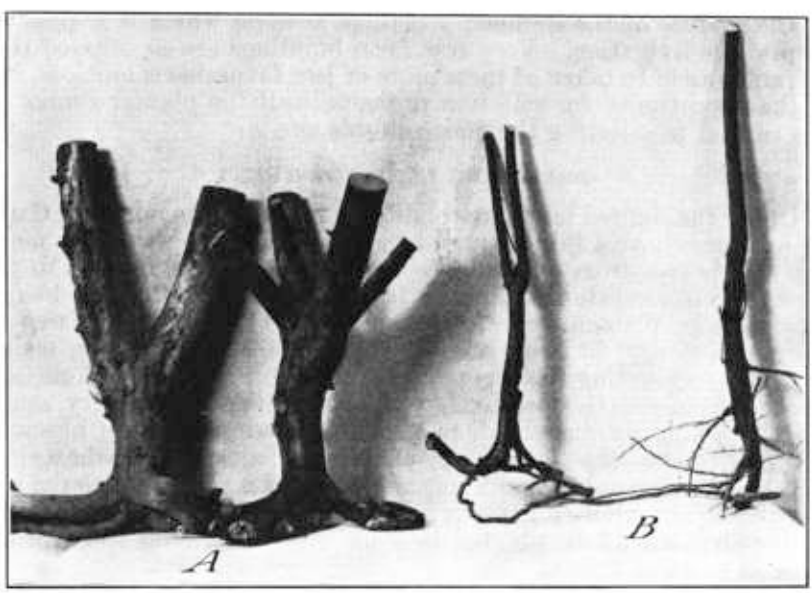

FIGURE 4.—Tree roots unable to penetrate the hardpan layer. *A*, Northwest poplar 10 years old in northern South Dakota. These trees died at the end of the tenth season after reaching a height of 9 feet. *B*, Green ash 10 years old in northern North Dakota. These trees were living but had reached a height of only 5 feet.

and allow a deep and wide penetration of tree roots. They show the highest proportion of stored moisture available to plants. An exception in this class may be made in very coarse sands and gravels, which permit much of the absorbed moisture to be lost by passing below the depth of penetration of tree roots. Light rains are beneficial in replenishing the amount of stored moisture in soils of the favorable class.

Semifavorable sites have soils of a medium texture, such as loams or clay loams. Such soils absorb rainfall somewhat more slowly and permit greater run-off than the coarse-textured soils. The moisture does not penetrate so deeply, resulting in less root penetration. More moisture being held in the surface layers offers the possibility of greater loss by evaporation. Light rains are not so beneficial in replenishing the amount of stored moisture in this class.

Unfavorable sites are those that have soils of a fine texture, such as clays; those that are underlain by hardpan; and those with soils too alkaline for tree growth. Moisture is absorbed more slowly and run-off is greater than from more pervious soils. Penetration of moisture is less, there is more tendency to shallow root development, and there is greater possibility of loss of water by evaporation from the soil. Light rains, which are beneficial in replenishing the stored moisture in the favorable class and to a less extent in the unfavorable class, are of little or no benefit to this class.

Exception to these classes may be made for trees planted along contour ditches; in local areas that have a precipitation greater than the average; on sites so situated that they collect considerable run-off water from surrounding territory; sites that have a water table close to the surface of the ground; and those sites on which it is possible to practice irrigation. Very few farm buildings are so situated that advantage can be taken of these more or less favorable conditions, but if the opportunity for selection presents itself the planter cannot be too careful in selecting the most suitable site.

PREPARING LAND FOR TREES

Under the limited moisture conditions found on the northern Great Plains, trees have a fair chance of success only when planted in moist soil that is free from sod and weeds. The best tillage method to put land in this condition is summer fallow. Land on which a shelterbelt is to be planted, therefore, should be (1) thoroughly freed of sod and (2) kept in clean summer fallow the entire growing season previous to planting the trees. Trees should not be planted on land broken from sod the previous year, except possibly on very sandy soils. Ordinarily grassland, particularly land supporting bluestem (*Agropyron smithii* Rydb.), commonly called western wheatgrass and bluejoint, requires a cultivation period of 2 years to free the soil thoroughly of all living roots. Light sandy soils that are subject to blowing should be planted to some cultivated crop rather than kept in summer fallow.

SUMMER FALLOW

The purpose of summer-fallowing land for tree planting is to store the maximum amount of moisture (1) by keeping the land free of all grass and weed growth and (2) by keeping the surface of the soil in a rough or ridged condition, which reduces loss of water from excessive run-off during heavy rains and is also effective in preventing wind erosion.

Land should be plowed to a depth of 6 to 8 inches not later than June 1, preferably before May 15. In the northern Great Plains about 25 percent of the seasonal rainfall occurs in June, and plowing must be done previous to this to store the maximum amount of moisture.

During the summer the land should be cultivated as often as is necessary to keep it free of plant growth. One cultivation late in the fall is advisable to ridge the soil to prevent blowing, to help in holding the snow on the land, and to retard run-off. On very exposed sites it may be necessary to plow or list furrows at right angles to the prevailing wind to prevent wind erosion or loss of snow during the winter.

A shovel or a duckfoot-type cultivator is preferable to a disk or a harrow for working the soil during the summer. A shovel-type implement leaves the surface of the soil in best condition for absorbing rainfall and preventing soil blowing. On old land, one plowing and three or four duckfoot cultivations will ordinarily represent all the labor necessary to summer-fallow land for tree planting.

FENCING

Provision should be made, before the trees are planted, for erecting a fence that will keep all classes of livestock away from the trees.

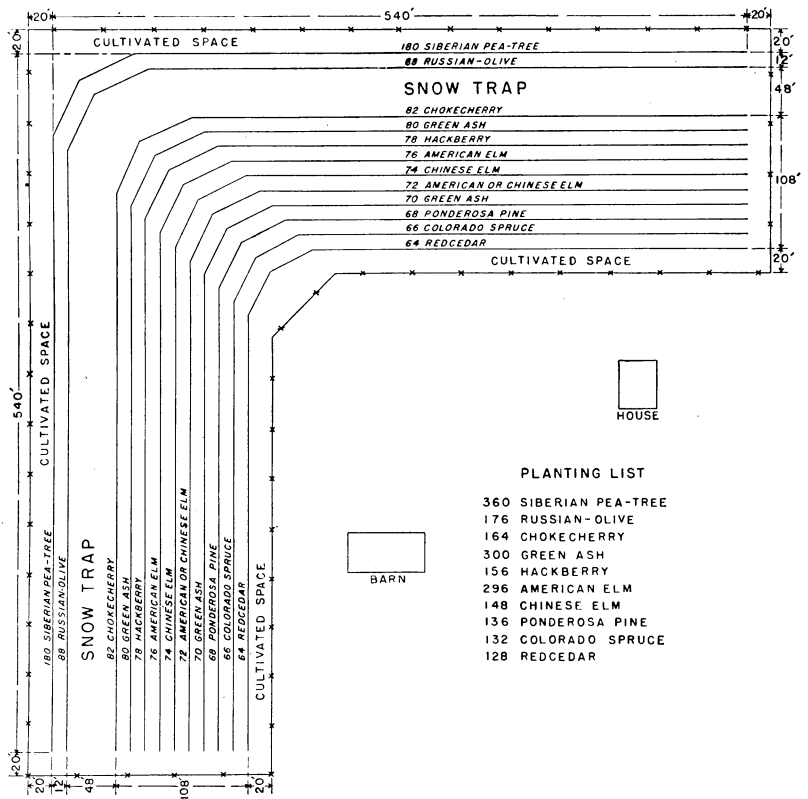

FIGURE 5.—Typical shelterbelt planting plan. Space rows 12 feet apart. Space Siberian pea-tree 3 feet apart in the row; all other species 6 feet.

Rabbit-proof woven wire makes the best type of fence but does not necessarily assure complete protection from rabbit injury, as thistles collecting against the fence will oftentimes cause snowdrifts of a sufficient height for rabbits to pass over the top or through the upper part of the fence.

PLANTING PLAN

Each prospective tree planter should prepare some form of planting plan showing the shape and size of the planting site, the kinds and arrangement of species, and the spacing distances to be used in setting out the trees. Figure 5 shows a typical shelterbelt plan which

can be modified to fit the actual conditions on a given farm. When belts are planted on two or more sides, the corners may be rounded off to make cultivation easier. Provision should be made for a strip of cultivated land at least a rod wide on all sides of the belt. Clean cultivation of this strip should be practiced at all times to prevent sod from gaining entrance to the trees and to act as a firebreak.

SUITABLE SPECIES OF TREES

For maximum wind and snow protection and as a precaution against possible destruction by insects or disease to which an individual species may be susceptible, better all-around results will

FIGURE 6.—Shelterbelt on the field station at Mandan, N. Dak., showing arrangement of species also snow trap and cultivated land about the belt.

be secured when two or more species are used in combination than when a shelterbelt is planted to only one species. Trees or shrubs that will form a dense growth close to the ground are most desirable for outside rows. Trees that attain greater height are best for interior rows. The different species should be so arranged that the growth will show a gradual progression from low trees in outside rows on either side to the tallest trees in the center rows. After a few years, an outline of the tops of trees will somewhat resemble the roof of a building. This is illustrated in figure 6, which shows a young planting on the station at Mandan, N. Dak.

Not all species of trees that have been found suitable for planting in shelterbelts on the northern Great Plains will grow equally well under the prevailing moisture conditions on the various soil types.

The species given in table 1 are generally suitable and are classified as to their most suitable position in the shelterbelt and their adaptation to the three soil classes previously described. An additional site class of low or wet sites has been included to take care of such situations when they occur in the area laid out for the shelterbelt. Only in exceptional cases will the whole shelterbelt be planted on a low or wet site, as good drainage is one of the first requisites for a building location. Coniferous species are much more difficult to establish than hardwood species, and consequently they should be planted in rows added to the hardwood belt, preferably on the inside, rather than in alternate rows of hardwood and coniferous species.

The suitability of the various species for the different site classes is indicated in table 1 by the symbols. It is not to be inferred that a species given the same symbol on all site classes will give equal growth and survival on all sites. It will, however, give approximately the degree of success indicated in comparison with other species on that particular site class.

TABLE 1.—*Trees suitable for planting in different sections of shelterbelts and on sites of different quality on the northern Great Plains*

Position in row and species	Suitability for planting in site classes indicated [1]					
	Favorable		Semi-favorable		Unfavorable, clay	Low or wet
	Sand	Sandy loam	Loam	Clay loam		
Broadleaf or deciduous species:						
For outside rows:						
Siberian pea-tree (*Caragana arborescens* Lam.)	0	F	G	G	G	0
Chokecherry (*Prunus virginiana* L.)	F	G	G	G	G	F
Lilac (*Syringa* sp.)	P	G	G	G	F	P
Tatarian honeysuckle (*Lonicera tatarica* L.)	P	G	G	G	G	F
Russian-olive (*Elaeagnus angustifolia* L.)	0	F	G	G	G	G
Silverberry (*Elaeagnus argentea* Pursh)	P	G	G	G	G	F
Serviceberry (*Amelanchier alnifolia* Nutt.)	F	G	G	G	P	G
Golden currant (*Ribes odoratum* Wendl.)	0	G	G	G	P	G
American plum (*Prunus americana* Marsh.)	F	G	F	F	0	G
For intermediate rows:						
Green ash (*Fraxinus pennsylvanica lanceolata* (Borkh.) Sarg.)	F	G	G	G	F	G
Hackberry (*Celtis occidentalis* L.)	G	G	G	G	F	G
Honeylocust (*Gleditsia triacanthos* L.)	0	G	G	G	F	G
Mossycup oak (*Quercus macrocarpa* Michx.)	P	G	G	F	P	G
Russian-olive (*Elaeagnus angustifolia* L.)	0	F	G	G	G	G
Boxelder (*Acer negundo* L.)	0	F	0	0	0	G
For center rows:						
American elm (*Ulmus americana* L.)	F	G	G	G	P	G
Chinese elm (*Ulmus pumila* L.)	P	G	G	G	G	0
White willow (*Salix alba* L.)	0	0	0	0	0	G
Laurel willow (*Salix pentandra* L.)	0	0	0	0	0	G
Russian golden willow (*Salix* sp.)	0	0	0	0	0	G
Cottonwood (*Populus* sp.)	0	F	0	0	0	G
Narrowleaf or coniferous species:						
For outside rows:						
Redcedar (*Juniperus virginiana* L.)	F	G	G	G	G	F
Colorado juniper (*Juniperus scopulorum* Sarg.)	F	G	G	G	G	F
Colorado spruce (*Picea pungens* Engelm.)	0	G	G	G	P	G
White spruce (*Picea glauca* (Moench) Voss and *P. glauca albertiana* (S. Brown) Rehder)	0	0	0	0	0	G
For intermediate rows:						
Ponderosa (western yellow) pine (*Pinus ponderosa* Dougl.)	F	G	G	G	F	P
Colorado spruce (*Picea pungens* Engelm.)	0	G	G	G	P	G
Douglas fir (*Pseudotsuga mucronata* (Raf.) Sudw.)	0	G	G	F	P	G
White spruce (*Picea glauca* (Moench) Voss and *P. glauca albertiana* (S. Brown) Rehder)	0	0	0	0	0	G

[1] Explanation of symbols: G=good; F=fair; P=poor; 0=not suited.

The species given in table 1 have given promise by actual test over a period of years either on the Mandan station or in farm plantings throughout the region. The list does not include all the trees that might be successfully grown on the northern Great Plains, but gives a number sufficient for most farmers to select a suitable shelterbelt. Local conditions of variations in soil, climate, and other factors may prevent the listed species from being successful on every planting site for which they are recommended. The tree planter, however, should be prepared to replace the unsuccessful species with those that have survived the particular conditions of his farm or with those that have given promise in the immediate locality.

SPACING DISTANCES

A shelterbelt cannot be fully effective in checking the wind and holding drifting snow until the branches of the trees have grown together. It is, therefore, necessary to adopt a system of spacing that will permit early branching together of the trees in the row but still leave sufficient space between rows for cultivation for the first few years. The spacing between rows, however, should be such that the crowns of the trees eventually will close in and thus shut out weed growth, prevent the entrance of sun and wind, thereby reducing the evaporation from the soil and trees, and aid the development of forest conditions within the belt. Such conditions may eventually result in the suppression of individual trees. These trees, however, can be removed without interfering with the desired crown cover or destroying the effectiveness of the belt.

A distance of 2 to 4 feet for low-growing shrubs in outside rows and 6 feet for trees in interior rows with rows 8 to 12 feet apart is recommended. Rows of trees of species having an upright form of growth with very little side branching should be planted about 8 feet apart, and those of species having spreading side branches and crown should be planted 12 feet apart. Species having an erect form of growth, rather than species with spreading crowns, should be planted in rows next to the low-growing species, to prevent the possibility of suppressing the latter.

PLANTING STOCK

Tree stock suitable for planting shelterbelts on the northern Great Plains may be obtained from one of the following sources: Commercial nurseries within the region; by collecting seed and cuttings and growing the stock on the farm; and by digging or pulling native seedlings from woodland areas nearby. A limited amount of planting stock is also available each year from Government and State agencies. The practice of pulling or digging native seedlings will not usually give as good results as the use of nursery-grown stock, which has a better root system. An exception to this is made for cottonwood seedlings, which can be pulled on river sand bars and transplanted with a high degree of success.

Under the prevailing climatic conditions, young trees of comparatively small size will give best results. For deciduous species, seedlings 1 to 2 years old and 1-year rooted cuttings make the best stock. Commercial nurseries usually grade and sell shelterbelt stock by height classes. Observations, however, resulting from the grading of

planting stock in diameter classes by the Mandan station during the last 13 years show that height is not so important as the diameter or caliper, sometimes called "stockiness", of planting stock. Best planting results have been obtained with stock measuring from ¼ to ⅜ inch in diameter just above the swelling of the root collar. Much of the stock of these sizes will range between 12 and 24 inches in height, although variations above and below these sizes will be found, depending on the density under which they were grown in the nursery rows. Stock that measures less than 3/16 inch in diameter will not give good planting results under unfavorable conditions, even though it is of suitable height. Such stock is too thin or spindly to withstand severe drying and frequently has a weak root system. Coniferous stock should be transplants from 6 to 12 inches high and from 3 to 5 years old. Preference should be given to trees of the smaller size.

The use of small stock makes it possible to dig with the root system practically intact. Such stock will give much better stands under unfavorable conditions than larger stock that has lost part of the root system in the digging operation. Small seedlings can also be purchased, transported, and planted more economically than seedlings of larger sizes.

In procuring nursery stock it is advisable to obtain from 10 to 20 percent more stock than the amount called for by the planting plan. This extra stock permits the selection of the more suitable diameter sizes and the discarding of injured trees. Undersized and other surplus stock should be planted in temporary nursery rows to form a source of supply for replacing losses in the permanent planting that may occur in the first year.

METHODS OF GROWING NURSERY STOCK

Most of the deciduous-tree or shrub seedlings suitable for planting shelterbelts on the northern Great Plains can be easily grown from seed by any farmer interested in growing his own stock. Seed of the recommended deciduous species is usually obtainable from native or planted trees in the region. The practice of growing coniferous stock from seed is not recommended for the average farmer, owing to the greater care required and the longer period necessary in the nursery. This class of stock should be purchased from commercial growers as seedlings and then planted in nursery rows to grow until of suitable size for transplanting to the permanent location. This will require 1 or 2 years for pine stock and 2 or 3 years for spruce stock.

The following methods are given to assist those farmers desirous of growing their own planting stock from seed.

SITES

A sandy loam or sandy soil in a good state of cultivation should be selected for the nursery site. This type of soil encourages good root development and makes it possible to dig the stock without seriously stripping or breaking the roots. The location of the nursery site near a water supply is advisable but not essential. Tree seedlings can be successfully grown from seed under dry-land conditions, but extended drought periods may retard their growth and necessitate an additional year in the nursery if artificial watering is not carried out.

SEED COLLECTION AND STORAGE AND PLANTING METHODS

The time given for the ripening of seed of the species discussed in the following paragraphs is only approximate, as the period may vary somewhat throughout the region. The species are treated in the order of time of ripening of the seed.

Stratification of tree or shrub seed, when recommended, is performed in the following manner: An amount of fine moist (not wet) sand equal in volume to the quantity of seed is spread on a tight floor. The seed is spread over the sand and thoroughly mixed by turning until each seed comes in contact with the sand. The mixture of sand and seed is placed in a suitable container such as a pail or box with 2 inches of sand in the bottom. Sufficient room should be left in the top of the container for about 6 inches of sand, to prevent drying out of the stratified material. Large seeds such as acorns and walnuts may be stratified directly in the container by placing alternate layers of sand and seed. Mixing on the floor is preferable for small seeds.

Stratified seeds should be stored at a fairly constant temperature of around 40° F. A basement or root cellar is usually suitable for this purpose. Wide fluctuations in temperature should be guarded against, and if a suitable storage space is not available the container and stratified seed should be buried outside with at least 1½ feet of soil over the top. Seed sometimes heats if stratified early in the fall. To prevent possible damage to the seed by heating, all containers should be examined periodically for the first month after stratification. The seed is removed from the sand for planting by passing the stratified material over a small-mesh sieve. This should not be done until immediately before planting.

American and Chinese elm seed ripens the latter part of May and should be collected as soon as it turns from a greenish to a grayish-brown color. Ripe seed is very easily blown off the trees, and the entire crop may be lost as a result of one windy day. For best results the seed should be planted shortly after collection, although it is possible to carry it over for a year if it is kept in dry condition. The seed is planted in trenches and covered with one-fourth inch of soil. The soil surface should be kept from crusting until the seedlings appear above ground. Chinese elm seedlings will reach sufficient size by the end of the first season for transplanting to the permanent site. American elm seedlings will generally require 2 years in the nursery. A few ounces of good-quality seed will produce all the seedlings needed for a farm shelterbelt.

Siberian pea-tree seed ripens early in July, and the pods should be collected shortly after they commence to turn brown. If collection is delayed too long after the change in color begins, many of the pods will have opened and thrown out the seed. Collected pods should be spread on a dry, tight floor for 2 to 4 weeks, at the end of which time they will have opened and thrown out the seed. Care should be taken to prevent the pods from heating during this period. A fanning mill or a small-mesh sieve will remove the opened pods and leaves from the seed. The seed may be planted in August if moisture conditions are favorable, or stored dry until the following spring. It is planted

in trenches from a quarter to half an inch deep, much as garden seeds are planted. Seed planted in August will produce seedlings large enough for transplanting at the end of the following season. Seedlings grown from seed planted in the spring will require 2 years in the nursery. Stock should be cut back immediately after being planted, to a height of about 4 to 6 inches to encourage branching close to the ground. About 6,000 usable seedlings can be grown from 1 pound of seed.

Serviceberry (Juneberry, Saskatoon) seed ripens in July. The flesh should be removed by mashing and washing and the cleaned seed stratified. The seed may be planted in trenches about ¼ inch deep either in the fall or in the spring. If fall-planted, the area should be mulched with hay or leaves. Some difficulty may be experienced in germinating the seed, and seedlings will require 2 years in the nursery. Rooted suckers may be dug from native clumps and transplanted successfully. One-half pound of washed seed will give all the seedlings necessary for a farm shelterbelt.

Chokecherry seed ripens in August, and should be collected soon after that time to prevent possible destruction of the crop by birds. The flesh is removed by mashing and washing, and the cleaned seed is stratified until fall, when it should be planted in trenches about an inch deep. If the seed has to be carried over until spring it should be placed in cold storage immediately after being cleaned and stratified, to prevent germination, which may occur during the late fall or early winter if the seed is kept at above-freezing temperatures. The seedlings will ordinarily make sufficient growth the first season to be ready to be transplanted. One thousand to fifteen hundred seedlings can generally be grown from 1 pound of cleaned seed.

Tatarian honeysuckle seed ripens in August but will remain on the branches for some time afterwards unless taken by birds. The flesh is removed by mashing and washing, and the cleaned seed may be planted immediately in trenches about ¼ inch deep or stratified and planted in the spring. If fall planting is practiced, the planted area should be mulched with hay or leaves over winter. Seedlings will ordinarily require 2 years in the nursery before reaching suitable sizes for transplanting. A few ounces of cleaned seed will grow all the seedlings needed for a farm shelterbelt.

Golden currant seed ripens in early August. The flesh is removed by mashing and washing. The cleaned seed should be stratified and may be fall-planted in trenches about ¼ inch deep or carried over until spring. Fall-planted areas should be mulched with hay or leaves during the winter. Seedlings will require 2 years in the nursery to reach suitable transplanting sizes. A few ounces of cleaned seed will produce all the seedlings necessary for a farm shelterbelt. Root suckers can be dug from planted bushes and transplanted very easily.

Lilac seed ripens in September and should be collected shortly afterwards to prevent loss by shattering. After the capsules become dry, most of the seed will drop out. It is then stratified. In the spring it is planted in trenches about ¼ inch deep. Seedlings will require 2 years in the nursery to reach suitable transplanting sizes.

A few ounces of cleaned seed will give all the seedlings necessary for a farm shelterbelt. Root suckers dug from planted clumps are readily transplanted.

American plum seed varies considerably in time of ripening but can usually be collected in late September. The flesh is removed by mashing and washing, and the cleaned seed may be either fall-planted in trenches about 1½ inches deep or stratified and kept over winter. Seedlings normally require 2 years in the nursery, although suitable sizes have been obtained in one growing season from fall-planted seed. Three to five hundred usable seedlings can be grown from 1 pound of washed seed.

Russian-olive seed is collected early in October and should be stratified over winter for best results. It is planted in trenches about 1 inch deep, and the seedlings reach suitable transplanting sizes the first season. About 600 usable seedlings can be obtained from 1 pound of seed.

Silverberry seed is collected, treated, and planted similarly to Russian-olive seed. Seedlings usually reach transplanting size the first season. An average of 300 to 500 usable seedlings is obtained from a pound of seed.

Hackberry seed is ready for collection early in October. It may be carried over winter dry, but better germination results from stratified seed. It is planted in the spring in trenches about 1½ inches deep, and the seedlings ordinarily reach suitable transplanting sizes at the end of the first season. About 800 to 1,000 usable seedlings can be obtained from 1 pound of seed.

Mossycup oak (bur oak) seed can be collected in October. The seed should be stratified over winter and spring-planted in trenches 1½ to 2 inches deep. The seed is frequently wormy, and yields may be expected to vary from 50 to 200 seedlings per pound of seed. The seedlings require 2 years in the nursery but should be undercut at the end of the first season to induce lateral root development. Best results will be obtained with this species by planting the seed directly in its permanent location. If this method is followed, three or four seeds should be planted together at intervals of the desired spacing distance in the row to insure a full stand. The resultant seedlings should be thinned later to one in a place. It may be necessary to protect the seed from rodents until the plants come up.

Green ash seed can be collected as soon as it turns brown, which is usually in late October. It may be either stratified or stored dry over winter; the best germination results are obtained from stratified seed. The seed is planted in trenches about half an inch deep, and the seedlings require 2 years in the nursery to reach suitable transplanting sizes. About 5,000 usable seedlings can be obtained from 1 pound of seed.

Boxelder seed is collected, treated, and planted similarly to green ash seed. Seedlings reach suitable transplanting sizes the first season. The seed varies considerably in quality, oftentimes being entirely worthless. About 4,000 seedlings can be grown from 1 pound of good-quality seed.

Honeylocust seed may be collected after the pods commence to turn a brownish black, usually in late October. The pods should be

dried and the seed extracted by threshing for large quantities or hand flailing for small amounts. The seed is carried over winter in a dry condition and planted in the spring in trenches about 1½ inches deep. Seedlings usually reach suitable transplanting sizes at the end of the first season. About 600 to 800 usable seedlings can be obtained from 1 pound of extracted seed.

Species such as poplar, cottonwood, and willow are very easily grown from cuttings. Cutting stock is taken in November after the growth has matured, from material of the current season's growth. Cuttings may be made about 9 inches long, tied in bundles with buds all pointing the same way, and buried over winter about 2 feet deep in well-drained soil, with the tops of the cuttings pointing down. Cuttings are spring-planted in a V-trench about 4 inches apart, placed at a slight angle, with only 1 bud above the soil surface. The soil should be firmly packed around each cutting. The stock will make sufficient growth the first season to be transplanted to the permanent site.

TIME OF PLANTING

In the northern section of the Great Plains, tree planting should be done in the early spring. The actual planting can be begun immediately after the frost is out of the ground and should be completed before the trees begin to send out leaves.

Fall planting of trees is not recommended, owing to the usually dry condition of the soil. The soil is subject to a certain amount of heaving and cracking during the winter, and it is not uncommon for fall-planted trees on heavy soils to be heaved out of the ground. If trees are received from the nursery in the fall, they should be carefully heeled in until the planting season opens in the spring. Home-grown stock should be dug and graded in the fall and heeled in over winter, or it may be allowed to remain in the nursery until spring if the necessary time can be spared from farming operations to dig and grade the stock.

CARE OF TREES BEFORE PLANTING

Although trees obtained from a nursery are usually packed so they will keep in the bundle for a period of a week to 10 days, they should be taken to the farm and unpacked as soon as possible. The shipment should be unwrapped in a cool, protected place and the roots thoroughly moistened. If the planting is to start at once, the trees may be kept for a short time by wetting down the packing material and repacking it about the roots. A cool cellar or barn is a suitable place to keep trees stored in this way. If planting is to be delayed for a week or more, the trees should be carefully heeled in.

To heel in trees, dig a trench the width of an ordinary plow furrow and about a foot deep, with one side sloping. The dirt from the trench may be placed along the sloping side to increase its height. Lay the trees against the sloping side, roots resting in the bottom of the trench, tops pointing up the slope, as shown in figure 7. Fill the dirt against the trees so as to cover the roots completely and the bottom portion of the tops, packing it well. Small bunches of trees that can easily be held in one hand may be heeled in without being

opened. Large bunches should be cut open and the trees spread out to allow the soil to be packed more closely around each tree root. Dry soil should be well soaked with water after the heeling-in operation is completed.

Trees will keep better if heeled in in a cool, shaded location than if placed where they will be exposed to the warm rays of the sun. It should be remembered that heeling in is a method of temporary storage. When the trees show signs of starting to send out leaves they must be planted without delay.

PLANTING THE TREES

Consult the prepared planting plan before setting out the trees. The position of the rows as shown on the planting plan should first be marked on the ground. Any practical method for assuring straight

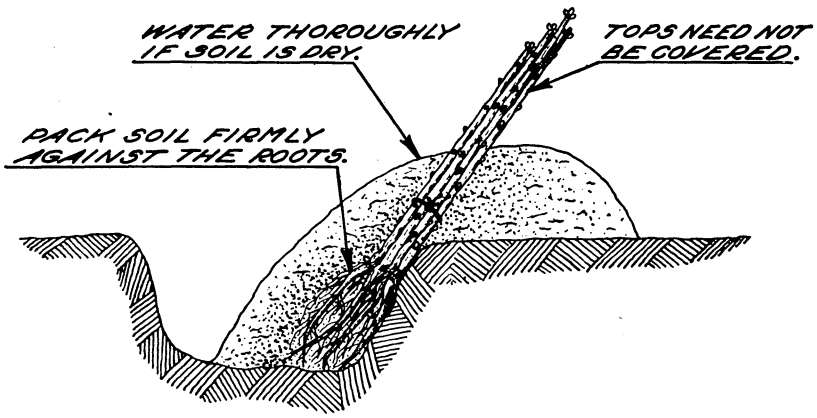

FIGURE 7.—Method of heeling in small bundles of trees.

rows may be used, such as setting stakes or stretching a line. Care should be taken to get the correct distance between rows and between the trees in the row.

A spade or a straight long-handled shovel makes the best planting tool. The trees may be planted by either the hole or the slit method, depending on the root system of the stock to be planted. Stock with spreading roots will require a hole, whereas stock with very small or very few lateral roots can be planted satisfactorily behind the spade or by the slit method.

Whatever method is used for planting, the following fundamental principles should be observed: (1) Keep the roots of the trees moist at all times by carrying them in a pail of water or wrapped in a wet sack; (2) make the hole or slit wide and deep enough to fit the roots of the stock to be planted; (3) set the tree a little deeper than it stood in the nursery; (4) pack the soil firmly about the roots. The soil should come in contact with all roots and be well firmed so that after the planting operation is completed it will not be possible to move the tree with a fairly strong pull of the hand. Correct and incorrect planting practices are shown in figure 8.

Trees cannot be successfully plowed in, but the planting work may be reduced by plowing a deep furrow and then digging in the bottom of the furrow. This practice is not recommended except in wet weather, as it tends to dry out the soil around the root area.

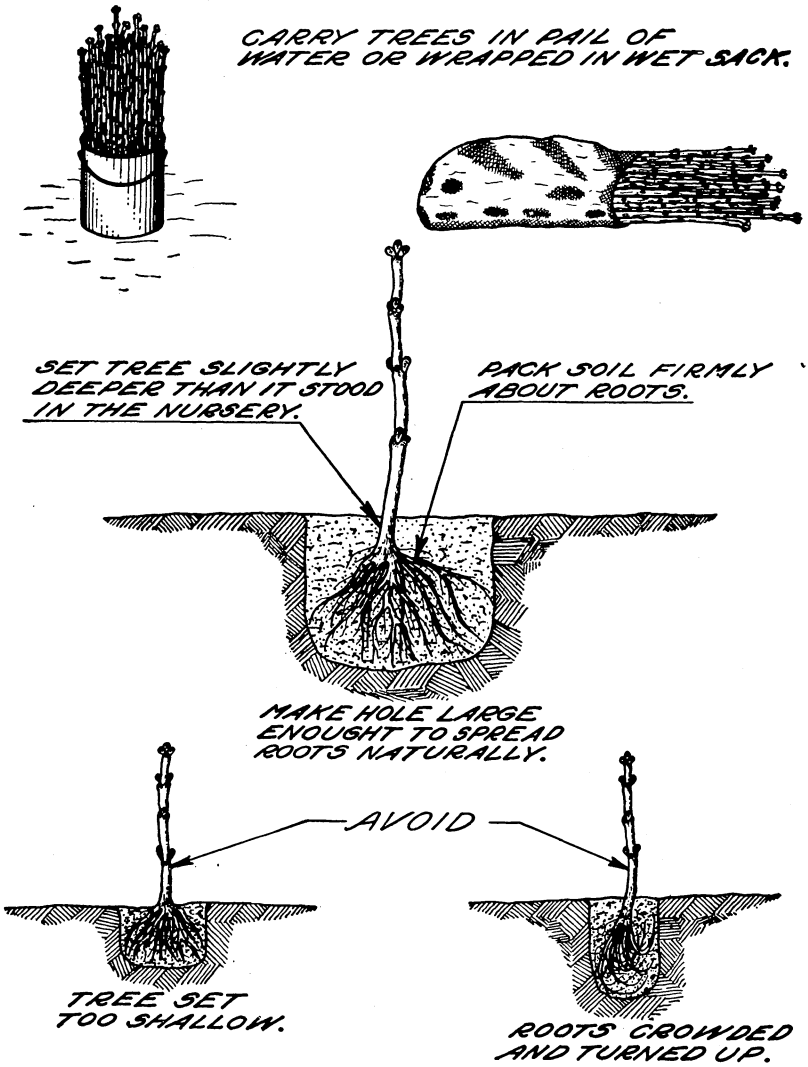

FIGURE 8.—Correct and incorrect practices in planting trees.

CARE OF TREES AFTER PLANTING

CULTIVATION

Cultivation to control weeds and keep the surface of the soil in condition to prevent excessive run-off and wind erosion is of primary importance in the care of trees on the northern Great Plains. Grass

and weeds compete with the trees for moisture, and clean cultivation should be practiced until such time as the trees develop overhead shade that will shut out competitive growth. Exception to this rule should be made in sandy soils that are subject to blowing. On such soils garden crops may be planted between the tree rows, or grain may be sown in the centers between them, keeping it at least 3 feet from the trees.

Ordinary farm machinery generally can be used satisfactorily for cultivation purposes. Shovel-type cultivators are preferable to machinery that leaves the ground in smooth condition. Suitable machinery found on most farms is the duckfoot cultivator, the one- or two-row cultivator, the spring-tooth harrow, and the one-horse garden cultivator. One-row cultivators are particularly suitable for the first 1 or 2 years, as cultivation can be practiced close to the trees by straddling the row similarly to cultivating corn. The space between rows can be taken care of with any wider machinery on hand. The tree planter must be prepared to use narrower machinery as the trees branch out. At this stage the spring-tooth harrow becomes a useful implement in that it is low enough to pass under the branches without causing serious injury.

Single disks should not be used for cultivating trees, as their continued use results in the soil being heaped against the base of the trees and a low center between the rows. This leads to heavy run-off with consequent injury to the trees. A tandem disk leaves the surface nearly level but pulverizes the soil into a condition that favors run-off and wind erosion.

MULCHING

Observations and studies made of tree plantings mulched with hay, straw, or manure as a substitute for cultivation do not warrant the recommendation of this practice, particularly during the early life of the planting. Mulching may be beneficial when applied 10 or 15 years after planting, but sufficient evidence is not available to recommend it even for older shelterbelts. However, mulching may be practiced on steep slopes to prevent excessive erosion in a planting of any age. In addition to the fact that mulching has shown no beneficial results when applied in the early life of the trees, certain very harmful results have been observed, such as harboring rodents, particularly mice, which girdle the trees; introducing weed seeds, which eventually grow up through the mulch; creating a serious fire hazard in the close proximity of farm buildings; preventing light rainfall from reaching the soil; and preventing the proper penetration of tree roots into the soil, keeping them up near the surface, where most of the moisture has been held by the mulch.

PRUNING

Pruning of shelterbelt trees should be practiced only to a very limited extent in the northern Great Plains. Such pruning as is done should be confined to corrective pruning rather than trimming the trees to a height of 5 or 6 feet. The latter practice has been found detrimental to growth and survival and destroys the protective value of the belt. The beneficial effects of pruning are confined to such early trimming off of branches close to the ground as will assure a

tree with a single, central trunk. The need for this type of pruning will vary with the different species.

Pruning of hedge-type species such as Siberian pea-tree in outside rows should be confined to cutting back tops to encourage branching close to the ground. Species in interior rows, such as ash, elm, hackberry, and poplar, should be pruned to develop a tree with a single central trunk rather than permit the development of two or more main trunks from near the ground. Ordinarily these species develop the single trunk; but top injury through killing back, or damage by rabbits, or mechanical injury may result in two or more main stems from near the base. The strongest and best of these new shoots should be allowed to remain and the others removed. Side branches from the main trunk should not be removed for a greater height than 1 foot above the ground. This corrective pruning should be carried out at the beginning of the second season or the season following that in which the injury occurred. A sharp knife or pruning shears should be used to remove branches close to the trunk, so that no stubs are left which would later decay. Large wounds should be painted with a dressing that will waterproof, disinfect, and protect against the entrance of fungi. Coal tar and creosote oil mixed together to the consistency of thick paint make a suitable dressing. A good-quality thick lead paint will serve in the absence of a more suitable dressing. It has no disinfectant properties, however, and has to be renewed periodically if it is to prevent the entrance of wood-rotting fungi.

Evergreen trees should not be pruned, except in cases where the terminal growth has killed back and a double leader appears. The weaker of these branches should be removed.

THINNING

Any thinning done in a shelterbelt in the northern Great Plains should not disturb the overhead shade of the crown cover or the base density of the outside rows. It should be confined to the removal of weak or injured trees that do not have tops extending into the main crown cover. Present data, derived from observation and study of cooperative shelterbelts over a period of 20 years, indicate that the removal of alternate rows or alternate trees in the row is not desirable. Whether such thinning may be desirable in closely planted belts when they reach an age of 25 to 30 years remains to be seen.

Before making any large-scale thinning in a shelterbelt the reasons for maintaining a fairly dense growth should be given careful consideration. Under Plains conditions it is necessary to hold the snow, to break the force of the wind, and to maintain shade within the belt. By holding snow that otherwise would blow away, additional moisture is stored in the soil. By breaking the force of the wind, the main purpose of the shelterbelt in protecting the home site is accomplished. By maintaining shade, grass and weed growth is prevented. Also, with shade and lessened air movement, the temperature within the belt is reduced, and there is less evaporation of moisture from the soil and transpiration from the trees. After summer rains, trees in dense plantings will retain moisture on their leaves many hours longer than trees in open belts.

DISEASE PREVENTION AND CONTROL[1]

Many fungus diseases enter the host through wounds. This is especially true of heartwood rots. Care should be exercised to prevent the wounding of trees in any way. If wounds do occur, such as caused by wind breakage of branches, the broken parts should be cut off and protected as already advised in another section of this bulletin. Livestock should be excluded from shelterbelts. They not only damage the trees directly, but trample and compact the soil, thus interfering with normal root development and occasioning subsequent reduction of the vigor of the trees and increased susceptibility to infection.

By the proper selection of tree species for a locality it is often possible to avoid serious damage from fungus diseases. Control measures also are sometimes necessary but should be resorted to only when precautionary measures have proved inadequate. Certain trees or shrubs sometimes serve as alternate hosts for rust fungi, which may in turn infect agricultural crops to their great detriment. To prevent infection it is necessary to eliminate one of the alternate host species.

CEDAR APPLE RUST

Cedar apple rust is particularly injurious to apple trees and results in serious reduction of the crop. Redcedars (*Juniperus* spp.) serve as alternate host trees for this disease and are in turn sometimes considerably damaged by the fungus infection. By restricting the use of redcedars in apple districts, infection of the apple trees will be reduced to a minimum. It is unwise, therefore, to plant any species of juniper in shelterbelts in the vicinity of established apple orchards.

Where apple crops are secondary to adequate windbreak protection, the apple trees should be discriminated against in favor of the junipers, since the latter are an especially desirable windbreak species. On the other hand, certain apple varieties are less susceptible than others to damage by this rust fungus, and if new orchards are planned such varieties might be used to advantage. In such a case the State plant pathologist should be consulted.

Other plants, relatives of the apple, may also act as the alternate hosts of this rust fungus; and it would be unwise, therefore, to plant such trees as hawthorn or wild crab apple in the same windbreak or in proximity to redcedars.

BUCKTHORN, HOST FOR CROWN RUST OF OATS

Although buckthorns (*Rhamus* spp.) are less commonly used now than in the past, it appears advisable to mention their connection with the perpetuation of the crown rust of oats. This rust does great damage to the oat crop. The buckthorns serve as alternate hosts for the rust. The European or common buckthorn (*Rhamnus cathartica* L.) is particularly susceptible to infection, therefore its use is, in general, undesirable.

Recent information indicates that the glossy buckthorn (*Rhamnus frangula* L.) is immune from crown rust in the United States, and that the dahurian buckthorn (*R. davurica* Pall.) is highly resistant to infection. These two species offer a possibility for substitution for

[1] By Ernest Wright, associate pathologist, Division of Forest Pathology.

the more susceptible species of buckthorn, if it is desirable to use them. Both species are hardy in the northern Great Plains.

STEM RUST OF WHEAT

The common barberry is sometimes used for hedge windbreaks, but it is undesirable, since it is the alternate host of the stem rust of wheat. The Japanese barberry (*Berberis thunbergi* DC.) could be considered as a substitute, since it is immune from stem rust. At present there are also some patented varieties on the market that are reported to be immune from infection. Before using barberry the State plant pathologist should be consulted for latest information on the most desirable species.

CANKER OF POPLAR AND WILLOW

Practically all species of poplars and willows are affected by a canker disease that makes them short-lived. This disease is so widespread throughout the country that it is practically impossible to prevent infection. Infection commonly takes place on branches and not uncommonly on the main trunk. The fungus causing the disease is a wound parasite and becomes readily established on weakened branches or trees. Proper care of the soil to conserve moisture and thereby promote good growth is perhaps the best means of prevention. Infected limbs should be removed before growth starts in the spring, and the wounds should be coated with some preparation such as asphalt paint to encourage callus formation and retard infection. In all cases the limbs should be cut off flush with the main limb or the trunk. Small stem cankers may be cut out, but trees infected with large stem or trunk cankers are doomed. Such trees should be removed and destroyed to reduce local infection.

Native cottonwood is less liable to canker injury than any of the other poplar species that have been tested at Mandan. It is able to stand more drought than most poplars that have been planted in the region. For these reasons the native cottonwood appears more suitable for use in windbreaks than any of the other poplars so far used in this region.

CONTROL OF INSECT PESTS[2]

Many forms of insects cause more or less damage to trees. They may be of three general types: (1) Leaf-damaging insects that actually eat the leaf, such as blister beetles, leaf beetles, and various kinds of caterpillars; (2) insects that feed by sucking the juices, such as the aphids or plant lice that occur on the growing shoots or on the leaves and the scale insects that remain attached to the bark; and (3) insects that damage the trunks or branches of trees and are classed under the name of borers.

LEAF-EATING INSECTS

The best general method of control for leaf-eating insects is spraying with lead arsenate. Use 1½ pounds of lead arsenate powder to 50 gallons of water (4½ level teaspoonfuls to 1 gallon of water). Mix just enough water with the powder to form a thin paste and then add to the full quantity of water required, churn the mixture

[2] Control measures recommended by the Bureau of Entomology and Plant Quarantine.

thoroughly, and keep it well stirred while spraying. Apply with any available type of orchard sprayer. For trees less than 5 or 6 feet in height, a compressed-air sprayer having a capacity of about 3 gallons, or a barrel sprayer mounted on a cart, sled, or wheelbarrow, will be found suitable. *As lead arsenate is a poison, it should be stored out of reach of children and livestock.*

Hand-picking will prove effective if the insects are few and confined to a small section of the planting, especially in the case of the large caterpillars. These will be killed quickly if dropped into a pail containing a small quantity of kerosene, or they may be crushed.

SAP-SUCKING INSECTS

Lead arsenate spray is not effective in combating sap-sucking insects. An effective material for controlling plant lice is 40-percent nicotine sulphate. This liquid should be mixed with water at the rate of one-half pint (1 cup) to 50 gallons of water (3 teaspoonfuls to 3 gallons of water). Add from 1½ to 2 pounds of soap, previously dissolved in water, to the 50-gallon mixture, or from 1½ to 2 ounces to the 3-gallon mixture, and apply with an orchard sprayer. Scale insects can be controlled by applying a dormant-season oil spray late in the fall or early in the spring while the trees are still inactive.

BORERS

Borers cannot be controlled by spraying. Sound trees are less liable to attack than injured trees. For this reason, if borers are found working on any species of trees, the danger of injury may be lessened by trimming smoothly all scars or wounds and painting the exposed wood with any good waterproof paint and by increasing the vigor of the trees by fertilizing and watering. Where the young borers can be detected, they may be removed with a sharp knife. All dying trees or branches containing borers should be burned to prevent the spread of the infestation. Where insects are working in the buds and twigs, the affected twigs should be cut off and burned while the insects are still present.

CONTROL OF ANIMAL PESTS[3]

Horses, cattle, sheep, and hogs may do great damage to a planting of trees and should be kept out of the shelterbelt by a stock-tight fence. Jack rabbits, field mice, and pocket gophers also may cause serious damage to shelterbelt plantings. An effective protection against jack rabbits, which have been the most destructive in the cooperative plantings, is a rabbit-proof, woven-wire fence. Encircling the bases of trees with woven wire of ¼-inch mesh or with some similar form of guard is an effective means of protection against mice, but is more practicable in orchards than in shelterbelts. In addition, the poisoned baits described in the following paragraphs have been found successful in controlling various kinds of rodents.

JACK RABBITS

POISONED ALFALFA LEAVES

Dissolve 1 ounce of strychnine sulphate in 1 gallon of hot water and sprinkle over 12 pounds of clean alfalfa hay leaves. Mix the

[3] Control measures recommended by the Bureau of Biological Survey.

poisoned leaves thoroughly until all moisture is absorbed. Should strychnine alkaloid be used, 1 quart of vinegar should be substituted for 1 quart of water in preparing the solution, and equally good results will be obtained.

POISONED OATS

Mix 1 tablespoonful of starch in one-half cup of cold water and stir into 1 pint of boiling water to make a thin clear paste. Mix 1 ounce of powdered strychnine with 1 ounce of powdered bicarbonate of soda (baking soda) and stir with the starch to a smooth, creamy mass. Stir in 1 teacup of table salt. Apply to 12 quarts of good, clean oats and mix thoroughly to coat each kernel. Each quart should make from 25 to 30 baits.

The poisoned baits should be distributed in the evening by placing small handfuls in lines a few feet apart along rabbit runways. If all baits remaining uneaten are removed the following morning, there will be less danger of poisoning domestic livestock.

FIELD MICE

STARCH-COATED GRAIN BAIT

Mix 1 tablespoonful of gloss starch in one-fourth teacup of cold water and stir into three-fourths pint of boiling water to make a thin, clear paste. Mix 1 ounce of powdered strychnine with 1 ounce of baking soda and stir into the starch to a smooth, creamy mass free from lumps. Stir in one-fourth pint of heavy corn sirup and 1 tablespoon of glycerin or petrolatum. Apply to 12 pounds of wheat or preferably steam-crushed whole oats and mix thoroughly to coat each kernel.

Steam-crushed whole oats are preferred by most rodents to wheat or other grain and are less likely to be eaten by birds. Place a scant teaspoon of the poisoned bait in used mouse burrows or scatter it along the surface runways under cover of vegetation. Mice eat bait most readily when exposed in runways under dense cover.

Poisoning should be done systematically. Work down each tree row and bait two or three holes or runways near each tree, or more if mouse sign is abundant. One quart of the bait to the acre for each treatment is sufficient for a moderate infestation of mice, but proportionately more is required if the mice are abundant.

POCKET GOPHERS

Pocket gophers are readily caught in any one of several makes of special traps commonly on the market. For ridding alfalfa fields, orchards, and long stretches of ditch embankments of them, a very successful and much more practical method is to poison them by the use of baits of vegetables or poisoned grain. Either the vegetable or the grain bait gives excellent results, but about 1 pocket gopher out of 10 will not eat a poisoned bait and must be trapped.

VEGETABLE BAITS

Cut carrots, sweetpotatoes, or parsnips into pieces about 2 inches long and one-half inch square, and wash and drain. From a pepper box slowly sift one-eighth ounce of powdered strychnine (alkaloid)

and one-tenth ounce of saccharin (ground together in a mortar) over about 2 quarts of the damp baits, stirring to distribute the poison evenly.

GRAIN BAITS

Dissolve 1 heaping teaspoonful of dry gloss starch in a little cold water and add to three-fourths of a pint of hot water. Boil, stirring constantly until a thin clear paste is formed. Mix together 1 ounce of powdered strychnine (alkaloid) and 1 ounce of baking soda, sift into the hot starch paste, and stir thoroughly to a smooth, creamy mass. Add one-fourth pint of corn sirup, 1 tablespoonful of glycerin, and one-tenth ounce of saccharin, and stir well. Pour this mixture over 13 quarts of oats, rolled barley, milo, or feterita, and mix thoroughly so that each kernel is evenly coated. Allow it to dry before it is used. It is important that only the best grade of thoroughly cleaned grain be used, as chaff absorbs and wastes much valuable strychnine, and poisoned weed seeds imperil useful bird life.

The runways, which are usually 4 to 8 inches beneath the surface, can be located by means of a probe made of any strong handle 1 inch in diameter and 36 inches long. One end should be bluntly pointed. Into the other end should be fitted a piece of ¼-inch iron rod, protruding about 15 inches and bluntly pointed. A foot rest aids in probing hard soils. By forcing down the iron rod near pocket-gopher workings, or a foot or two back of fresh mounds, the open tunnel can be felt as the point breaks into it. The blunt end of the instrument is then used carefully to enlarge the hole, and a vegetable bait or two, or a tablespoonful of grain bait, is dropped into the run, and the probe hole closed. If a shovel is used instead of a probe to locate the runways, care should be taken not to disturb the runway more than necessary. Close the hole so as to keep out the light, taking care that loose dirt does not fall upon the baits placed in the runway.

SOURCES OF ADDITIONAL INFORMATION

Further information on matters pertaining to shelterbelts and specific recommendations for the control of any serious infestation of insects or symptoms of disease that appear on leaves, branches, or trunks may be obtained from the county agricultural agent, the Northern Great Plains Field Station, Mandan, N. Dak., or the following agencies in the different States: State or extension forester, Bottineau, N. Dak., and agricultural college, Fargo, N. Dak.; extension forester or agricultural college, Brookings, S. Dak.; extension forester or agricultural college, Bozeman, Mont.; and extension forester or agricultural college, Laramie, Wyo., and Central Great Plains Horticultural Field Station, Cheyenne, Wyo.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	HENRY A. WALLACE.
Under Secretary	M. L. WILSON.
Assistant Secretary	HARRY L. BROWN.
Director of Extension Work	C. W. WARBURTON.
Director of Finance	W. A. JUMP.
Director of Information	M. S. EISENHOWER.
Director of Personnel	W. W. STOCKBERGER.
Director of Research	JAMES T. JARDINE.
Solicitor	MASTIN G. WHITE.
Agricultural Adjustment Administration	H. R. TOLLEY, *Administrator.*
Bureau of Agricultural Economics	A. G. BLACK, *Chief.*
Bureau of Agricultural Engineering	S. H. MCCRORY, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Biological Survey	IRA N. GABRIELSON, *Chief.*
Bureau of Chemistry and Soils	HENRY G. KNIGHT, *Chief.*
Commodity Exchange Administration	J. W. T. DUVAL, *Chief.*
Bureau of Dairy Industry	O. E. REED, *Chief.*
Bureau of Entomology and Plant Quarantine	LEE A. STRONG, *Chief.*
Office of Experiment Stations	JAMES T. JARDINE, *Chief.*
Food and Drug Administration	WALTER G. CAMPBELL, *Chief.*
Forest Service	FERDINAND A. SILCOX, *Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*
Bureau of Plant Industry	FREDERICK D. RICHEY, *Chief.*
Bureau of Public Roads	THOMAS H. MACDONALD, *Chief.*
Resettlement Administration	W. W. ALEXANDER, *Administrator.*
Soil Conservation Service	H. H. BENNETT, *Chief.*
Weather Bureau	WILLIS R. GREGG, *Chief.*

U. S. GOVERNMENT PRINTING OFFICE: 1937

For sale by the Superintendent of Documents, Washington, D. C. - - - - Price 5 cents